INSTITUTE OF TERRESTRIAL ECOLOGY
(NATURAL ENVIRONMENT RESEARCH COUNCIL)

JNCC/NERC CONTRACT BAT/98/42

ITE PROJECT T08051h5

STATUS OF THE PUFFIN *FRATERCULA ARCTICA* ON THE ISLE OF MAY NATIONAL NATURE RESERVE

M P HARRIS and S WANLESS

Report to Scottish Natural Heritage

Hill of Brathens
Banchory Research Station
BANCHORY
Kincardineshire
AB31 4BY

July 1998

CONTENTS

SUMMARY

1. A complete count of burrows occupied by puffins in April 1998 estimated the Isle of May population at 42,000 occupied burrows (95% Confidence Interval, 39,000-45,300). The Isle of May now has one of Britain's largest colonies.

2. The population on the reserve has increased at an average rate of 11% per annum over the period 1970-98.

3. The rates of increase were greatest in the most recently colonised areas.

4. The population increase is predicted to continue.

5. The population should be counted every 4 years.

2. BACKGROUND

The Isle of May NNR is currently the main breeding colony of puffins *Fratercula arctica* in the Firth of Forth and is among the three largest colonies in east Britain, south of Shetland. The puffin is a qualifying species for the Forth Islands Special Protection Area which was designated 25 April 1990. A whole island count of the population was carried out in 1992 but since then the population has increased substantially and the species has colonised new areas of the island. These recent changes were not documented in detail and in April 1998, Scottish Natural Heritage placed a contract with the Institute of Terrestrial Ecology to determine the status (population size and distribution) of the puffin on the Isle of May NNR. This document reports on the status of the puffin as determined by a whole-island count of occupied puffin burrows and puts the count into an historical perspective.

3. METHODS

The count was undertaken between 24 and 27 April 1998 by a team of five counters - Sarah Wanless, Suki Finney, Keith Ferry, Sally Oldfield and Tom Wigglesworth. Checks of (a) the efficiency of counting and (b) the classification of burrows were made by Mike Harris.

The counting unit employed was the 'apparently occupied burrow' which was defined as a burrow showing signs of use by puffins, i.e. fresh digging, droppings or regular wear. There is potential for confusion between a rabbit and a puffin burrow but the

former tends to be much larger, to have much more substantial diggings and characteristic droppings in the entrance. Prior to the count, all the counters were given a practical demonstration by Mike Harris of how to identify occupied puffin burrows and a sample of burrows were checked by the whole team to ensure that differences between individuals were minimised. The timing of the count was ideal, weather conditions were good, the population of rabbits was at its yearly low and there was little new growth of vegetation to obscure burrow entrances. Subsequent checks of burrows indicated that laying had just commenced. For convenience, in the rest of this report we use the term 'burrow' instead of 'occupied puffin burrow'.

The island was divided into the areas routinely used in the annual count of gull nests. Some of these areas were further sub-divided to allow comparison with past burrow counts. Burrows were counted by dividing each area into strips 25 m wide with the boundaries marked with bamboo canes. Each observer searched a strip about 5 m wide by zig-zagging slowly along it. Where there was potential for overlooking burrows or double-counting them, a cane was used to scrape the earth in the entrance of each burrow as it was counted.

In 10 areas, small sections of the colony were delimited with string and the burrow entrances were marked with a spray of paint as they were counted . Each counter marked two sections. Immediately following the count, Mike Harris made a detailed examination of each possible burrow, where necessary lying on the ground and feeling to the end of the burrow with a bamboo cane to check for (a) puffin burrows which had been overlooked (i.e. were unmarked), (b) burrows which belonged to a

rabbit rather than a puffin, (c) entrances which were not true burrows (e.g. were very short), and (d) cases where there were two entrances to a single burrow (i.e. the burrow had been counted twice). Double-occupancy of a burrow, where two pairs use a single entrance, is extremely rare and the possibility of this was ignored.

Among previous burrow counts, which have always been made in late April, only in 1992 had a similar occupancy check been made. Then, based on checks made in four areas, the count was thought to have over-estimated the population by 7%. In 1998 checks in these same four areas suggested an under-estimate of 6%. The interaction between overlooking and misclassification of burrows will vary from area to area and year to year with a whole range of factors such as the state of the vegetation, soil erosion, burrow density, numbers of rabbits. For comparison with previous counts we use the uncorrected burrow counts.

In some figures, counts are plotted on a natural logarithmic scale where a significant linear trend indicates exponential growth in numbers.

4. RESULTS

Burrows were recorded in all the main parts of the island where there was sufficient soil except for the lighthouse garden (though even here birds stand on the walls, and have to be rescued when they fall in) and the field between the Mouse House and Chapel. The total (uncorrected) count was 41,542 burrows. Area totals are presented in Table 1 and are shown in more detail in the appended maps.

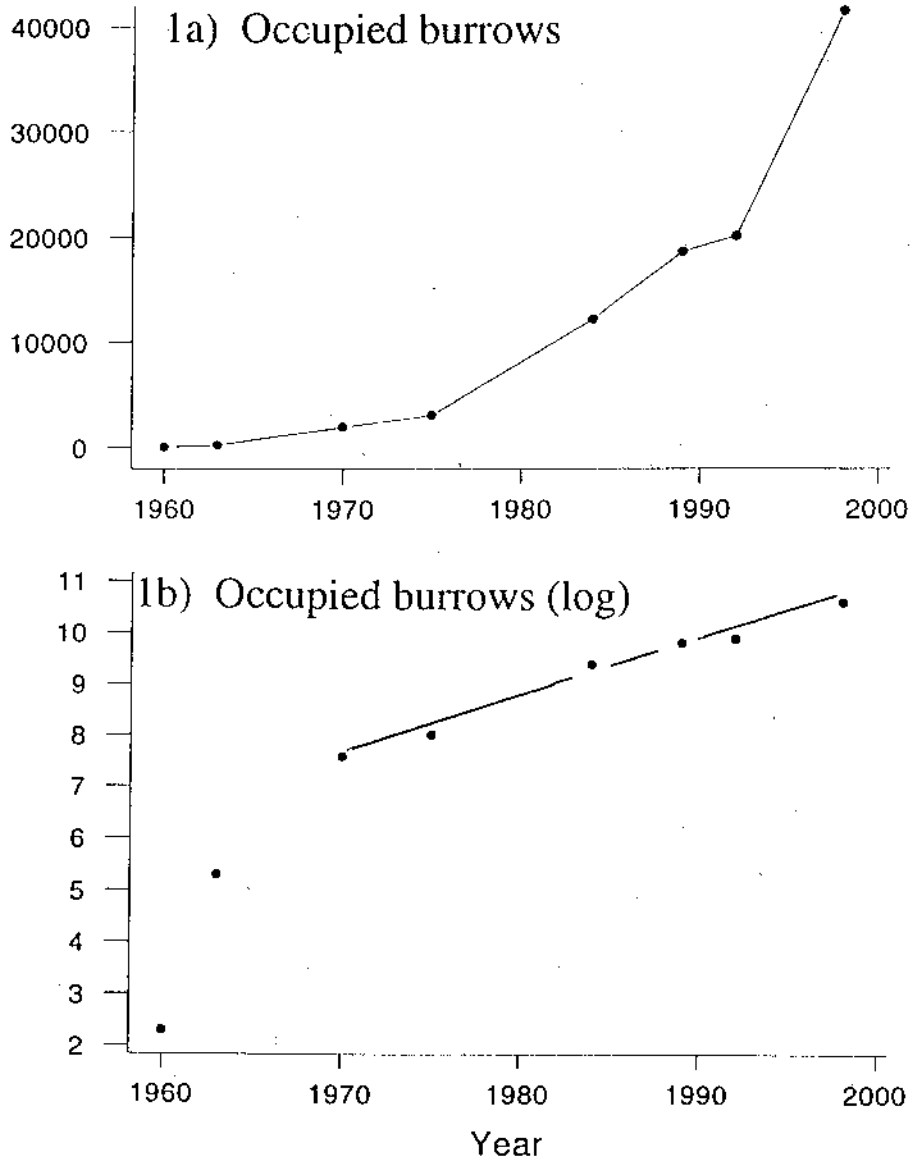


Fig. 1 Changes in the numbers of occupied puffin burrows on the Isle of May, 1960-98 plotted (a) directly and (b) on a log-scale. The plotted line shown on (b), number (log) = 0.11 year-210, indicates a highly significant linear rate of increase (R^2 = 98.3%, P = 0.0001) over the period 1970-1998.

Results from the 10 sections used to estimate observer error indicated considerable spatial variation in the various sources of error with raw counts both under- and over-estimating the corrected totals (Table 2). The mean correction factor for the 10 sections was 1.01 (SE = 0.03, 95% CI 0.94-1.09). Applying these values to the raw count data (and rounding off the figures to the nearest hundred) gives a corrected total of 42,000 occupied burrows (95% CI 39,000-45,300 occupied burrows).

5. COMPARISON WITH PAST COUNTS

The history of the puffin on the Isle of May is well documented (Eggeling 1960, Harris 1977). There are no very early records but in 1883 there were 30-40 pairs and Southern (1938) suggested maybe 50 pairs in 1936. The population was put at 5-10 pairs in the early 1950s but in 1957-58 at least 50 pairs attempted to form a colony. This attempt was brief and unsuccessful and in 1960 there were only a few pairs, all breeding in cliff-fissures, although 40 birds prospected the Burrian. The next year 200-300 birds were recorded on the Burrian. In June 1962 at least 500 birds were present on the island, breeding was recorded in the slopes above Colm's Hole and some birds were standing west of Holyman's Road. In 1963, approximately 200 pairs bred, including the first on Rona since 1957. In 1970, the population was put at about 2,000 pairs. The first systematic census of the Isle of May puffin colony was made in 1975 and whole island counts were subsequently made in 1984, 1989 and 1992. Details of these are presented in Table 1 and the population trend between 1960 and 1998 is shown in Figure 1a. Plotting the counts on a log scale (Fig. 1b) indicates that the rate of increase between 1970 and 1998

has been constant at 11% per annum (se = 0.7%).

Between 1992 and 1998, the highest proportional increases in burrow numbers occurred on South Plateau (a rise from 635 to 5262), and lowest on Burrian (5142 to 7388) and North Ness (3604 to 5287). The proportional increases, shown area-by-area in Table 3, confirm general field observations which suggest that the rates of increase in some of the longest established parts of the colony are slowing down whereas numbers are increasing rapidly in newly colonised areas, notably South Plateau and some of the inland areas.

6. THE ITE MONITORING SCHEME

In June 1972 a group led by D. Bellamy set up 7 large permanently marked quadrats, each of about 1000 m^2, and all in areas where the density of puffin burrows was relatively high. Scientists from ITE have recorded the number of occupied burrows in each of these quadrats in late April every year up to the present and several additional quadrats have been established to monitor changes in some of the recently colonised area. These detailed counts allow changes in puffin numbers to be examined in more detail.

Between 1972 and 1980 numbers increased at an average rate of 19% p.a. The rate then slowed abruptly and there was very little increase in numbers between 1986 and 1993 (Fig. 2). The cessation of the rapid increase between 1980 and 1981 coincided with a significant trebling of the annual mortality of breeding adults from

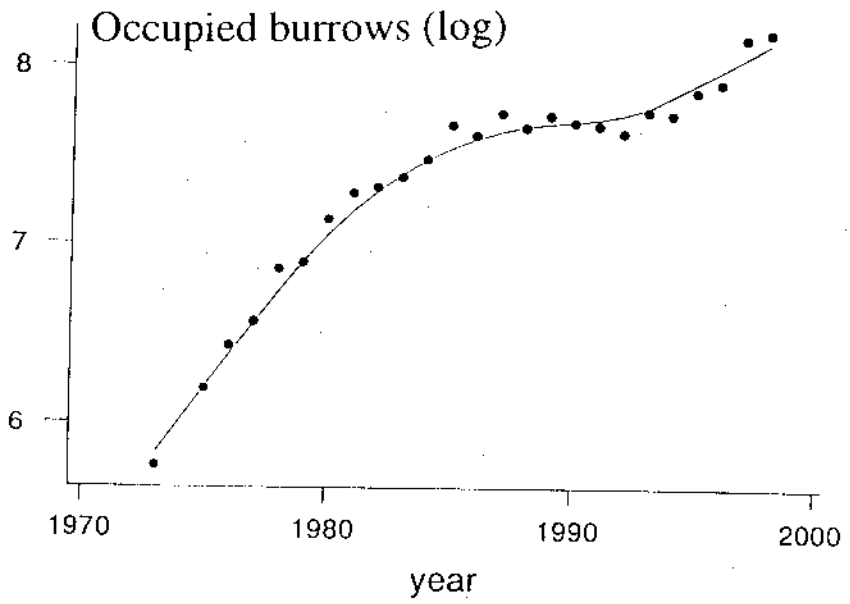


Fig. 2. Counts of occupied puffin burrows in monitoring plots between 1973 and 199
Population growth appeared to slow down in 1981 and speed up about 199

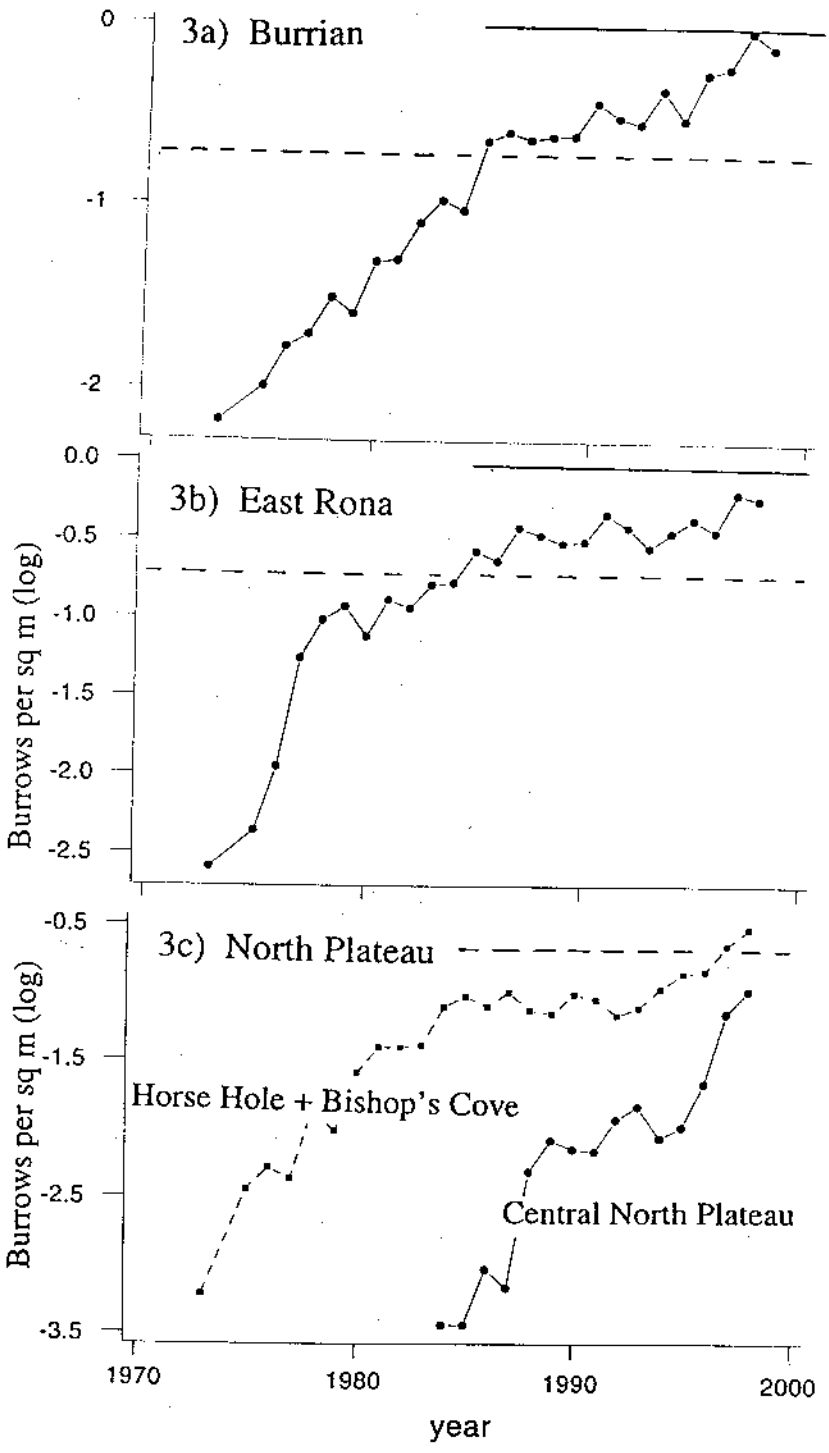


Fig. 3. Annual estimates of density of occupied burrows (burrows per m^2, log-transformed) on (a) Burrian, (b) East Rona and (c) North Plateau. In (c), the density in the newly colonised areas (circles) increased rapidly whereas that in the long-established areas (squares) has increased only slightly in recent years. The horizontal dashed and solid lines indicate densities of 1.0 and 0.5 burrows per m^2.

2.5% prior to 1980 to 7.6% after (Harris et al. 1997). The population increase recommenced around 1995. Preliminary analyses suggest that the adult survival also improved around this time which may have contributed to the rise in numbers. This pattern of change differs somewhat from the significant continual linear increase in numbers suggested by the whole island counts Whether this is due to the paucity of complete counts or the monitoring plots being unrepresentative of the whole population is unclear.

There is a finite upper limit to burrow density, probably in the order of 1 burrow per m^2 depending on the physical e.g. slope, soil depth and type and biological e.g. vegetation cover, characteristics of the area. Expressing counts of quadrats in terms of average burrow density (after omitting habitat unsuitable for burrowing) illustrates that, in general, the long established areas such as Burrian, east Rona, Bishops Cove and above Horse Hole are now close to this upper limit (Fig. 3). In contrast, burrow density in more recently colonised areas, for example central North Plateau, is still relatively low which suggests that there is still considerable potential for numbers to increase further.

7. THE FUTURE

With a current total of 42,000 burrows the Isle of May puffin colony is now the largest in east Britain, although that on the Farne Islands has not been counted since 1993 when it had 35,000 burrows. Indeed, in Britain and Ireland only the colonies on St Kilda, Shiant Islands and Sule Skerry are larger. Adult survival and breeding

success of Isle of May puffins are known to be high, and the large numbers of immatures seen ashore suggest that survival from fledging to first breeding is also high. Moreover burrow density is still low in large areas of the island with apparently suitable breeding habitat. Taken together these factors suggest that, at least in the short term, the Isle of May puffin population will continue to increase.

Only islands lacking ground predators can support large numbers of puffins and every attempt must be made to ensure that no ground predator becomes established on the island. Most islands off the east coast of Britain now have nesting puffins, but the vast majority of birds in the central and south North Sea occur at just three sites, the Farne Islands, Coquet Island (both in Northumberland) and the Isle of May. All the Farne Islands and Coquet are smaller than the Isle of May and have large puffin populations which have increased substantially during the last few decades; there seems limited scope for further expansion at either location. The thriving colony on the Isle of May with its extensive areas of low burrow density is likely to attract large numbers of recruits from other colonies. Thus the rate of increase could conceivably be even higher than at present.

Given the large amount of apparently suitable habitat in which burrow density is currently low, there is plenty of scope for the colony to increase substantially in the future. The area of the island is 55ha. Assuming that just 50% of this is suitable for puffins, that none of the already occupied high density areas become unsuitable and an average density of 1 burrow/m^2, this give a theoretical maximum colony size of about a quarter of a million burrows. The current scheme to monitor changes in the

numbers of puffins was installed when the population was only 5% its present size. Despite attempts to keep pace with geographic spread, the scheme is now inadequate A new monitoring scheme could be devised, possibly some form of stratified random sampling, perhaps using the SNH-grid recently surveyed on to the island. However, a complete and thorough survey such as that carried out in 1998 undertaken every 4 years by people familiar with the island and the species would be the most efficient way of documenting population changes.

8. REFERENCES

Eggeling, W.J. 1960. The Isle of May. Oliver & Boyd, London.

Harris, M.P. 1977. Puffins on the Isle of May. Scottish Birds 9: 285-290.

Harris, M.P., Freeman, S.N., Wanless, S., Morgan, B.J.T. and Werhham, C.V. 1997. Factors influencing the survival of Puffins *Fratercula arctica* at a North Sea colony over a 20-year period. Journal of Avian Biology 28: 287-295.

Southern, H.N. 1938. A survey of the vertebrate fauna of the Isle of May, Firth of Forth. Journal of Animal Ecology 7: 144-154.

Table 1. Counts of occupied puffin burrows on the Isle of May on 23-27 April 1998 compare to counts in 1975, 1984, 1989 and 1992. Count areas are shown in Map 1.

Area	**1975**	**1984**	**1989**	**1992**	**1998**
Kirkhaven to Colm's Hole	345	1518	2458	2525	5174
Colm's Hole to Low Light (Burrian)					
Quadrat	144	378	570	612	941
Rest	968	2408	3522	4530	6447
TOTAL	**1112**	**2786**	**4092**	**5142**	**7388**
Holyman's Road (West side)					
South of Colm's Hole (East Braes)	40	561	1068	1078	2584
North of Colm's Hole (Tower)	63	347	517	414	1323
Low Light to Tarbet	75	380	795	497	1213
Tarbet Cliff to Nybo Bridge	0	0	0	19	67
Rona					
East quadrats	34	165	211	233	279
West quadrats	19	46	80	70	135
Rest	496	2360	2946	3015	4734
TOTAL	**549**	**2571**	**3237**	**3318**	**5148**
North Ness	160	225	371	286	139
North Plateau					
Horse Hole quadrat	147	609	656	556	1000
Bishop's Cove quadrat	76	163	79	169	370
North of Three Tarn Nick to top of Horse Hole	83	1193	1698	2531	6060
South of Three Tarn Nick (but excluding Loch Side)	10	182	226	590	2525
TOTAL	**316**	**2147**	**2659**	**3846**	**9955**
South Plateau					
Pilgrim's Haven to Loch	23	105	394	389	2616
Loch Sides (incl. Mill Door, both sides below Dam)	c.10	c.100	c.150	246	410
TOTAL	**33**	**205**	**544**	**635**	**3026**
South Horn	9	15	c.100	150	585
Maidens	5	2	0	0	2
Ardcarron Gulley to Kirkhaven	113	274	635	530	1324
Lady's Bed	244	1180	2152	1620	3351
West Braes	0	0	0	20	24
Horse Hole to Altarstanes	0	0	0	20	98
St Andrew's Well area	0	0	0	6	31
Bridge-Altarstanes	0	0	0	0	8
Fields (Tennis Court, Chapel, Cross Park)	0	0	0	0	102
GRAND TOTAL	**3064**	**12211**	**18628**	**20106**	**41542**

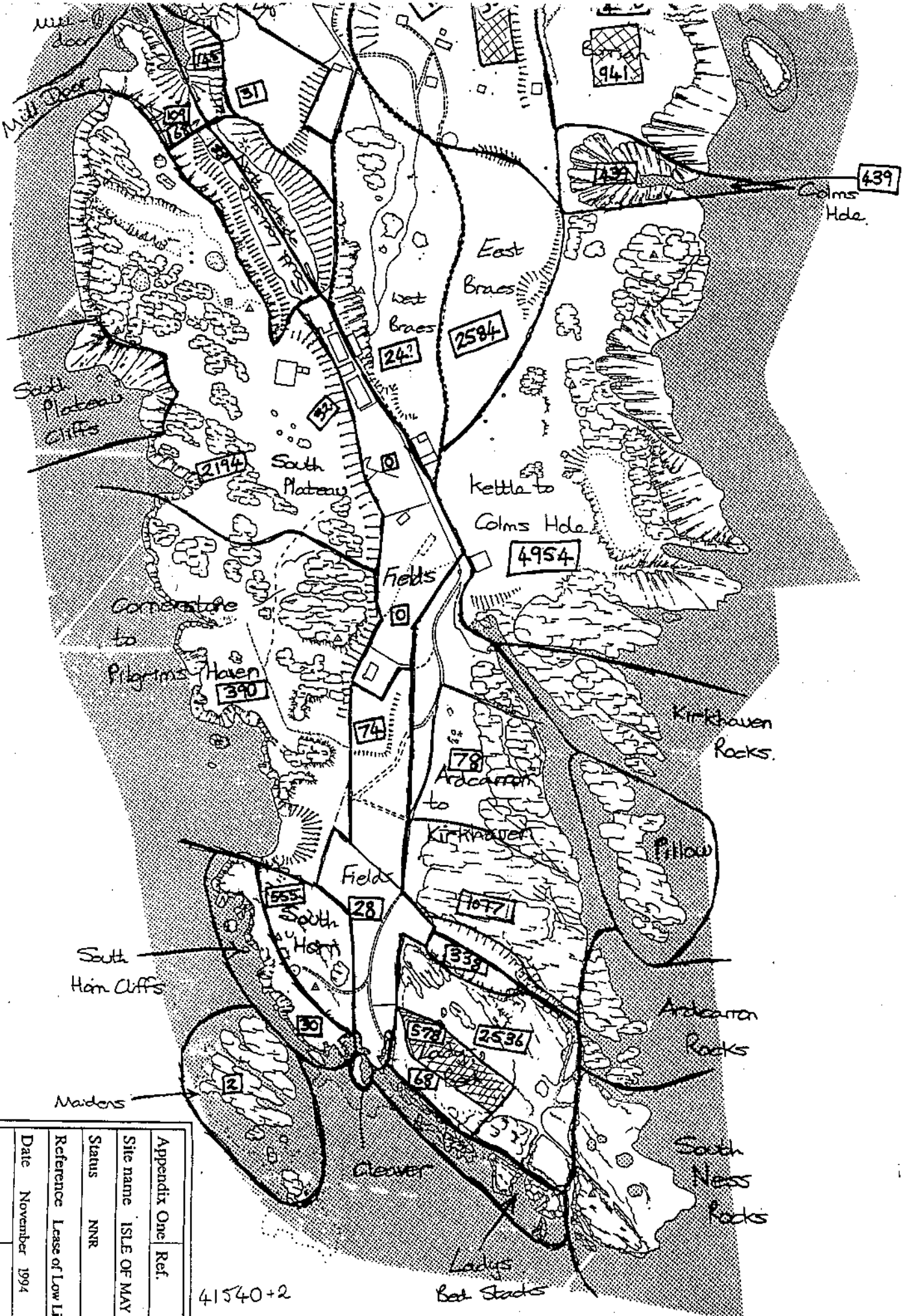
The 1998 count was made by S. Wanless, M.P. Harris, S. Finney, K. Ferry, S. Oldfield and T Wigglesworth.

Table 2. Checks of burrow counts and classification of puffin burrows in 10 sections of the colony on the Isle of May in 1998.

Area	Count made	Mistaken classification		Correctly classified (A)	Missed (B)	Corrected Total A + B	Correction factor for Area
		Too short or rabbit	Joined another burrow				
Rona	66	2	1	63	5	68	1.03
Tarbet-Low Light	50	2	2	46	2	48	0.96
Burrian	54	0	0	54	13	67	1.24
Kettle	87	12	2	73	14	87	1.00
Lady's Bed	84	4	4	76	4	80	0.95
East Brae	61	2	1	58	9	67	1.10
North of Three Tarn Nick	28	0	0	28	2	30	1.07
South of Three Tarn Nick	50	2	4	44	0	44	0.88
Tower	23	4	0	19	2	21	0.91
South Plateau	19	2	1	16	3	19	1.00
Total	**522**	**30**	**15**	**477**	**54**	**531**	**1.02**
					Mean		**1.01**
					S.E.		**0.03**
					95% C.I.		**0.94-1.09**

Table 3. Percentage changes in numbers of occupied puffin burrows in the main sections of the Isle of May between 1992 and 1998.

Area	1992	1998	% increase
Kirkhaven-Colm's Hole	2525	5174	105
Burrian	5142	7388	44
East Braes and Tower	1492	3907	162
Low Light to Nybo Bridge	516	1280	148
Rona and North Ness	3604	5287	47
North Plateau	3846	9955	159
South Plateau	635	3026	377
South Horn to Kirkhaven	2300	5262	129
Total (includes other areas)	**20106**	**41542**	**107**



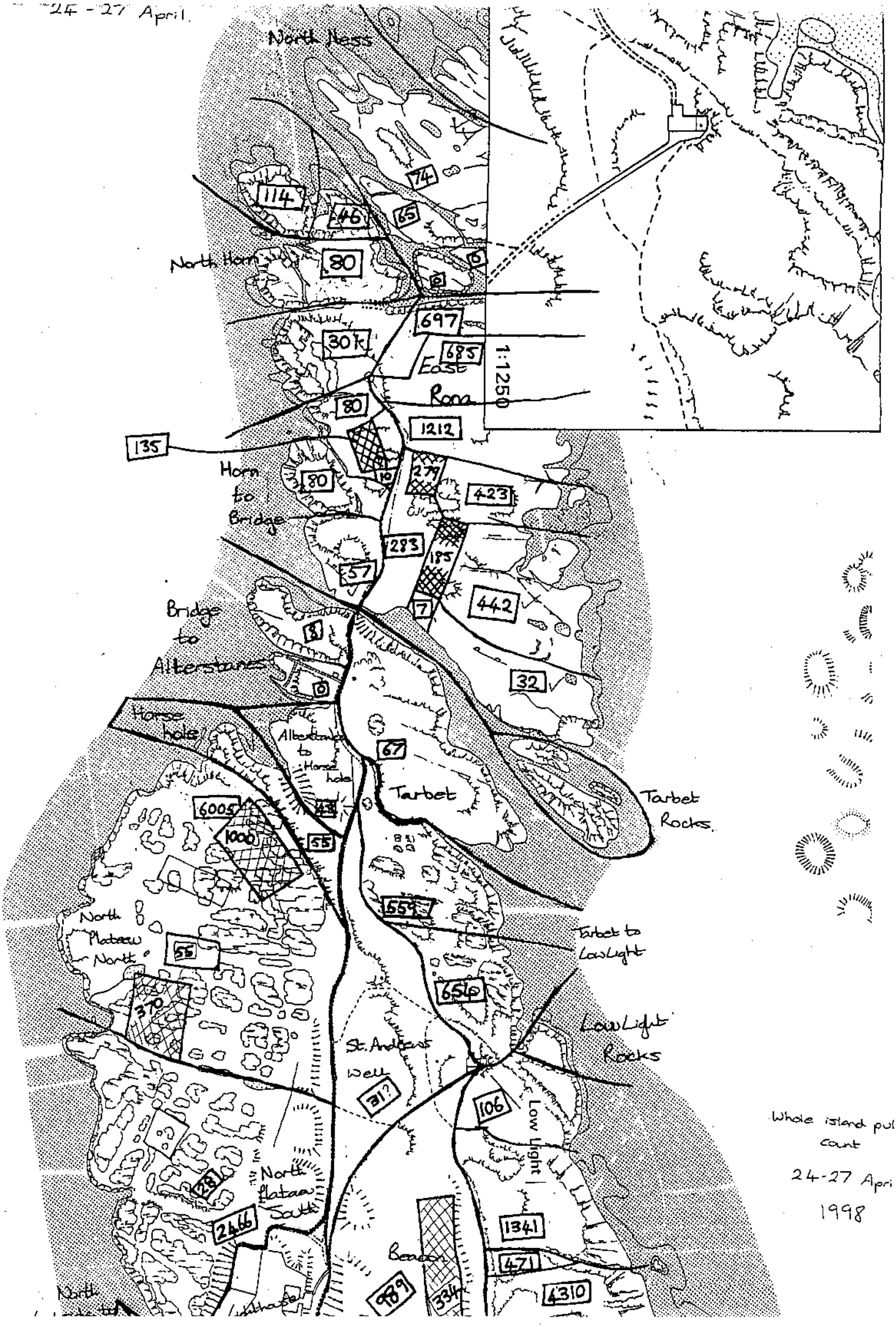
Appendix One	Ref.		
Site name ISLE OF MAY			
Status NNR			
Reference Lease of Low Light			
Date November 1994			
Scale 1:2500	Area 0.01406 ha		

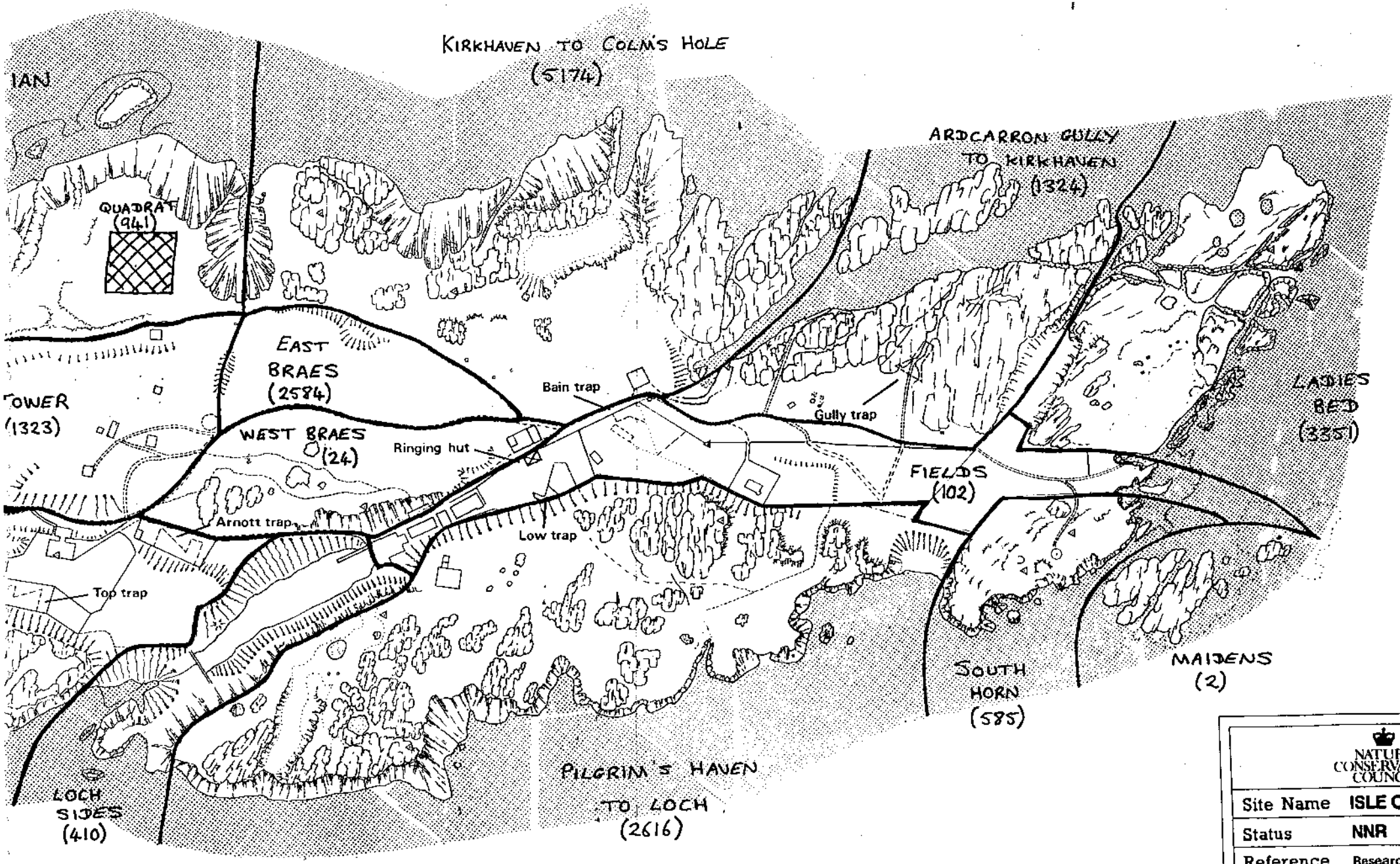
SCOTTISH NATURAL HERITAGE

12 Hope Terrace
Edinburgh
EH9 2AS
Tel. 031 447

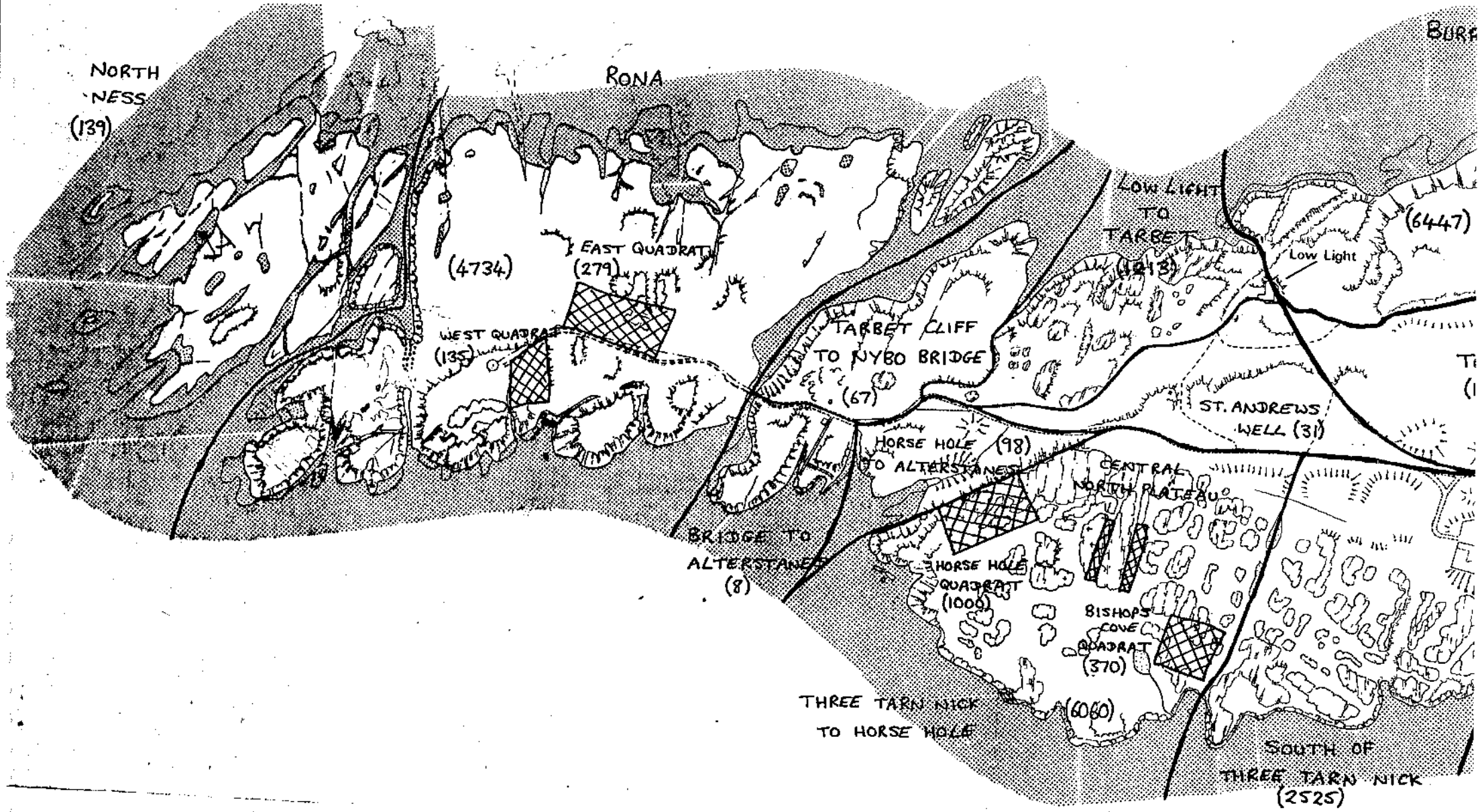
No. GD03C

Whole island puffin count


24 - 27 April
North Ness
North Horn
Horn to Bridge
Bridge to Alterstanes
Horse hole
Alterstanes to Horse hole
Tarbet
Tarbet Rocks
Tarbet to Low Light
Low Light Rocks
North Plateau North
North Plateau South
St. Andrew's Well
Low Light
Beach
East Rona
1:1250
114
46
65
74
80
697
685
307
1212
135
279
423
283
185
57
442
32
67
6005
1000
55
559
56
370
651
106
1341
471
4310
334
989
2466
Whole island pul count
24-27 Apri
1998



	NATURE CONSERVANCY COUNCIL
Site Name	ISLE OF MA
Status	NNR
Reference	Research Agre
Date	February 19
Scale 1:2500	Area


NORTH NESS (139)
RONA
(4734)
EAST QUADRAT (279)
WEST QUADRAT (135)
TARBET CLIFF TO NYBO BRIDGE (67)
LOW LIGHT TO TARBET (1213)
Low Light
(6447)
ST. ANDREWS WELL (31)
HORSE HOLE TO ALTERSTANES (98)
CENTRAL NORTH PLATEAU
BRIDGE TO ALTERSTANES (8)
HORSE HOLE QUADRAT (1000)
BISHOPS COVE QUADRAT (370)
THREE TARN NICK TO HORSE HOLE (6060)
SOUTH OF THREE TARN NICK (2525)